461 ACAB

Simpson

INSTRUMENTS THAT STAY ACCURATE

OPERATOR'S MANUAL

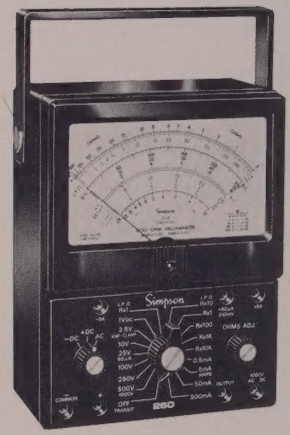
WARNING

For safe usage, it is essential that the operator read this manual carefully before using the instrument for any measurements.

MODEL 461
DIGITAL MULTIMETER

SIMPSON ELECTRIC COMPANY

853 Dundee Ave., Elgin, Illinois 60120
Area Code 312, Telephone 697-2260
In Canada, Bach-Simpson, Ltd., London, Ontario



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Printed in U.S.A.
3-77

Part No. 6-110119

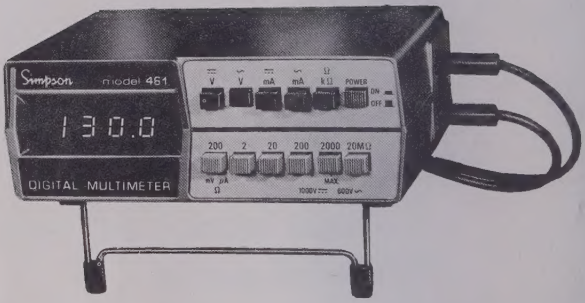

Figure 1-1. Model 461 Digital Multimeter

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WARNING

This instrument is designed to prevent accidental shock to the operator when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read carefully and completely before making any measurements. Failure to follow directions can result in a serious or fatal accident.

SHOCK HAZARD: As defined in American National Standard, C39.5, Safety Requirements for Electrical & Electronic Measuring & Controlling Instrumentation, a shock hazard shall be considered to exist at any part involving a potential in excess of 30 volts rms (sine wave) or 42.4 volts DC or peak and where a leakage current from that part to ground exceeds 0.5 milliampere, when measured with an appropriate measuring instrument defined in Section 11.6.1 of ANSI C39.5.

NOTE: The proper measuring instrument for the measurement of leakage current consists essentially of a network of a 1500 ohm non-inductive resistor shunted by a 0.15 microfarad capacitor connected between the terminals of the measuring instrument. The leakage current is that portion of the current that flows through the resistor. The Simpson Model 229-Series 2 AC Leakage Current Tester meets the ANSI C39.5 requirements for the measurement of AC leakage current and can be used for this purpose. To measure DC Leakage current, connect a 1500 ohm non-inductive resistor in series with a Simpson 0-500 DC microammeter and use this as the measuring instrument.

SECTION I

INTRODUCTION

1.1 GENERAL

1.1.1 The Model 461 Digital Multimeter is a compact, 3-½ digit instrument suitable for use in general electronic maintenance, production, and laboratory. It features 0.5% DCV accuracy, integrated circuit electronics, solid-state LED display, and push button switch selection for ranges and functions. Additional features are automatic polarity, automatic zeroing, high input impedance for voltage measurements, and excellent temperature and overranging characteristics.

1.1.2 The 461 requires 120 VAC to charge its batteries and will operate for eight hours continuously on a full charge. Recharging is automatic when the Instrument is in the OFF position and with the charger connected to the 120 VAC line. In an emergency, commercially available "AA" size batteries can be used. Refer to paragraph 6.5 for precaution and instructions.

1.1.3 The 461 (see Figure 1-1), measures DC and AC voltage, DC and AC current and resistance as specified in Table 1-1. The analog-to-digital (A/D) conversion circuitry is contained in one Large-Scale-Integration (LSI) module which provides high reliability and compact design.

1.1.4 The numerical display is a 7-segment light-emitting-diode (LED) display for easy viewing and solid state reliability. The numerals are 0.3 inch high and in a single plane for distant and wide-angle viewing. Ambient lighting effects are minimized by a filter which reduces reflections and background illumination.

1.2 ACCESSORIES AND SUPPLIES

All supplies and accessories required for the operation of the 461 are furnished with the Instrument and listed in Table 7-1. Rechargeable nickel-cadium batteries are included with the 461.

1.3 TECHNICAL DATA

Table 1-1 lists the technical specification for the Model 461 Digital Multimeter.

Table 1-1. Technical Data

1. DC VOLTAGE:

Range	Maximum Indication	Input Resistance	Overload Protected To
200 mV	±199.9 mV	10 MΩ	±1100 V
2 V	±1.999 V	10 MΩ	±1100 V
20 V	±19.99 V	10 MΩ	±1100 V
200 V	±199.9 V	10 MΩ	±1100 V
1000 V	±1000 V (Max. Input)	10 MΩ	±1100 V

Accuracy: (23°C ±5°C)	±(0.5% of reading + 1 digit)
Sensitivity:	100μV on 200 mV range
Full Range Step Response: (to rated accuracy)	1 second, maximum
Normal Mode Rejection:	40 dB minimum at 60 Hz
Common Mode Rejection:	90 dB minimum at 60 Hz
Temperature Coefficient: (from 0°C to +55°C)	±(0.025% of reading + 0.1 digit)/°C

2. AC Voltage: (Average-Sensing, RMS Calibrated Sine Wave)

Range	Maximum Indication	Input Impedance	Overload Protected To
200 mV	199.9 mV	10MΩ and 100 pF	650 V RMS
2 V	1.999 V	10MΩ and 100 pF	650 V RMS
20 V	19.99 V	10MΩ and 100 pF	650 V RMS
200 V	199.9 V	10MΩ and 100 pF	650 V RMS
600 V*	600 V (Max. Input)	10MΩ and 100 pF	650 V RMS

*Frequency Range: 50 Hz to 400 Hz.

Accuracy: (23°C ±5°C)	±(1.0% of reading + 2 digits), 50 Hz to 1000 Hz. ±(5.0% of reading + 2 digits), 1000 Hz to 5 kHz.*
Sensitivity:	100μV on 200 mV range
Full Range Step Response: (to rated accuracy)	5 seconds, maximum
Temperature Coefficient: (from 0°C to +55°C)	±(0.05% of reading + 0.2 digit)/°C

3. RESISTANCE:

Range	Maximum Indication	Full Scale Voltage	Test Current	Overload Protected To
200 Ω	199.9 Ω	200 mV	1 mA	135 V RMS**
2 kΩ	1.999 kΩ	2 V	1 mA	135 V RMS**
20 kΩ	19.99 kΩ	2 V	100 μA	250 V RMS
200 kΩ	199.9 kΩ	2 V	10 μA	250 V RMS
2000 kΩ	1999 kΩ	2 V	1 μA	250 V RMS
20 MΩ	19.99 MΩ	2 V	100 nA	250 V RMS

Accuracy: (23°C ±5°C)	±(0.5% of reading + 1 digit) except on the 20 MΩ range, which is ±(1.0% of reading + 1 digit)
Sensitivity:	0.1Ω on 200Ω range
Full Range Step Response: (to rated accuracy)	2 seconds, except on 20 MΩ range, which is 7 seconds
Temperature Coefficient: (from 0°C to +55°C)	±(0.05% of reading + 0.1 digit)/°C

*On 200 mV, 2 V, 20 V only.

**250 V for 5 seconds or less.

4. DC CURRENT:

Range	Maximum Indication	Full Range Voltage Drop	Overload Protected To
200 μA	±199.9 μA	200 mV	±2.0 A*
2 mA	±1.999 mA	200 mV	±2.0 A*
20 mA	±19.99 mA	200 mV	±2.0 A*
200 mA	±199.9 mA	200 mV	±2.0 A*
2000 mA	± 1999 mA	200 mV	±2.0 A*

Accuracy: ±(1.0% of reading + 1 digit), except on 2000 mA, which is ±(1.5% of reading + 1 digit)

Sensitivity: 100 nA on 200 μA range

Full Range Step Response: (to rated Accuracy) 1 second

Temperature Coefficient: (from 0°C to +55°C) ±(0.05% of reading + 0.1 digit)/°C

5. AC CURRENT (40 Hz to 1 kHz):

Range	Maximum Indication	Full Range Voltage Drop	Overload Protected To
200 μA	199.9 μA	200 mV	2.0 A*
2 mA	1.999 mA	200 mV	2.0 A*
20 mA	19.99 mA	200 mV	2.0 A*
200 mA	199.9 mA	200 mV	2.0 A*
2000 mA	1999 mA	200 mV	2.0 A*

Accuracy: (23°C ±5°) ±(1.5% of reading + 2 digits), except on 2000 mA which is ±(2.0% of reading + 2 digits)

Sensitivity: 100 nA on 200 μA range

Full Range Step Response: (to rated accuracy) 5 seconds, maximum

Temperature Coefficient: (from 0°C to +55°C) ±(0.1% of reading + 0.2 digit)/°C

*Fuse Protected

6. *RATED CIRCUIT-TO-GROUND VOLTAGE:

(Maximum Common Mode Voltage)	1000 volts (DC plus peak AC) maximum from any measuring terminal to power line (earth) ground terminal.

7. RESOLUTION: 1 part in 2000

8. DISPLAY:

Numerical Display:	3-1/2 digit, 7-segment light-emitting-diode (LED) type; display blanks, except for the most significant "1" digit at 2000 counts and above.
Conversion Rate:	3 readings per second, nominal
DC Polarity Selection:	Automatic

9. POWER REQUIREMENT:

Battery Charging (AC operating)	120 VAC ±10% or 230 VAC ±15% 50-400 Hz, 3 VA nominal
Battery Operation	Four nickel-cadmium "AF" size rechargeable cells, are included. (Each cell is rated at 1.25 V, 0.8-ampere-hour).
Battery Operation Time: (continuous with fully charged battery)	8 hours, nominal
Battery Recharge Time:	12 hours, nominal

10. TEMPERATURE RANGE:

Operating:	0°C to +55°C
Storage:	−40°C to +60°C

11. RELATIVE HUMIDITY:

Operating:	0 to 90% (non-condensing)

12. REFERENCE CONDITIONS:

Temperature:	+23°C ±1°C
Relative Humidity:	30 to 60%
Atmospheric Pressure:	575 to 800 mmHg to alt. of 2286m (7,500')

13. DIMENSIONS:

Height:	2 in. (50.8mm)
Width:	5.63 in. (143 mm)
Depth:	4.6 in. (116.8 mm)

*Per ANSI C39.5 April 1974 — "the specified voltage with respect to ground which may be safely and continuously applied to the circuits of an instrument.

SECTION II

INSTALLATION

2.1 UNPACKING AND INSPECTION

2.1.1 Unpack and inspect the Instrument for possible damage in shipment. Check the electrical performance as soon as possible. If damage is noted, notify the carrier and supplier before using the Instrument. Also check that all items are included (Table 7-1).

2.1.2 Save the shipping carton and packing materials for future storing or shipping of the Instrument.

2.2 POWER SOURCE REQUIREMENTS

The 461 is a battery operated instrument. The batteries are factory installed in the instrument and should be charged overnight before operating. Connect the charger supplied to the appropriate external power source. Refer to the markings on the charger for power source requirements.

WARNING

The Model 461 is designed specifically to be used with the Simpson 120 VAC Charger, Cat. No. 00745, or the 230 VAC Charger, Cat. No. 00746, which are adequately insulated to permit use of the Model 461 while being charged. If a substitute charger is used, make certain it is insulated for at least 600 VAC or 1000 VDC between the primary and secondary circuits in accordance with applicable safety standards.

2.3 INSTALLATION

The Instrument may be set horizontally on its rubber feet or vertically on its back and operated in either position. The Instrument can also be set at an inclined angle by positioning the stand under the unit.

SECTION III

CONTROLS, CONNECTORS AND INDICATORS

3.1 GENERAL

All operating controls, connectors, and indicators are described in Table 3-1. Become familiar with each item prior to operating the Instrument for the first time.

3.2 FRONT AND SIDE PANEL DESCRIPTION

Table 3-1 lists all front and side panel controls, connectors and indicators (see Figure 3-1, 3-2 and 3-3 for identification).

Table 3-1. Front and Side Panel Description

1. POWER Switch: ON OFF	Pushbutton switch used to apply or turn off power to the Instrument.
2. FUNCTION Switches:	Connect the input to the appropriate measuring circuits.
3. RANGE Switches:	Select the appropriate circuits required to obtain full range measurements.
4. Numerical Display:	The digital display uses LED's and includes a polarity sign, a "1" digit, three 7-segment type 0 to 9 digits and a decimal point, to indicate the polarity and the value of the signal being measured. The decimal point is properly positioned by the selection of the range switch. Over-range (or out-of-range) condition is indicated by a blank display, except for the most significant "1".
5. "+" Jack:	This terminal is used to connect the "high" side of the circuit being measured to all voltage and resistance and current measuring circuits through the range and function switches.

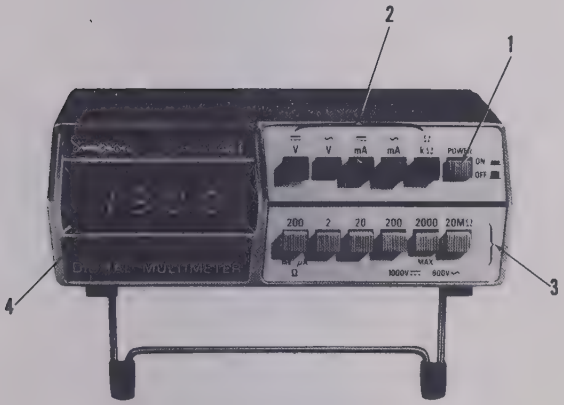

Figure 3-1. Front Panel Description

Figure 3-2. Right Side Panel Description

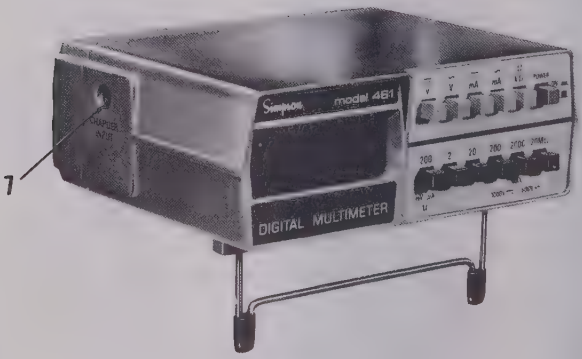

Figure 3-3. Left Side Panel Description

6. "–" Jack: This jack is used to connect the "low" side of the circuit measured to the internal circuit COMMON and is isolated from the AC power line ground. (See Table 1-1, item 6.)

7. CHARGER INPUT: This receptacle accepts the DC power from the charger.

SECTION IV

OPERATION

4.1 GENERAL

WARNING

The 461 is designed to prevent accidental shock when properly used. However, no engineering design can render safe an instrument which is used carelessly. Therefore, this manual must be read completely prior to making any measurements. Failure to do so can result in a serious or fatal accident.

This section of the manual contains information required to use and operate the 461 in a safe and proper manner.

4.2 SAFETY PRECAUTIONS

4.2.1 The 461 is designed to be used only by personnel qualified to recognize shock hazards and trained in the safety precautions required to avoid possible injury. Refer to SHOCK HAZARD definition on page v.

4.2.2 Do not work alone when making measurements where a shock hazard can exist. Notify another person that you are, or intend to make such measurements.

4.2.3 Remember, voltages might appear unexpectedly in defective equipment. An open bleeder resistor can result in a capacitor's retaining a dangerous charge. Remove all power and discharge all capacitors in the circuit being measured before making connections to or disconnections from it. The Instrument itself is well protected against electrical overload, as noted throughout paragraph 1.3. However, the above precautions are wise even in the laboratory, and especially in field usage of the Instrument where many strange or unknown safety hazards might prevail.

4.2.4 Locate all voltage sources and accessible paths prior to making any measurements or connections.

4.2.5 For your own safety, before each use, inspect the test leads, prods, connectors and power cable for cracks, breaks or crazes in the insulation. If any defects exist, destroy and replace defective item(s) immediately.

4.2.6 Do not make measurements in a circuit where corona is present. Corona can be identified by a pale-blue color eminating from sharp metal points in the circuit or a buzzing sound, or the odor of ozone. In rare instances, such as around germicidal lamps, ozone might be generated as a normal function. Ordinarily, the presence of ozone indicates presence of high voltage, and probably a malfunction of some kind.

4.2.7 Hands, shoes, floor and workbench must be dry. Avoid making measurements under humid, damp, or other environmental conditions that could affect the dielectric withstanding voltage to the test leads or the Instrument.

4.2.8 For maximum safety, do not touch test leads, circuit, or Instrument while power is applied to the circuit being measured.

4.2.9 Use extreme caution when making measurements in the rf circuit where dangerous composite voltages could be present, such as in an rf amplifier.

4.2.10 Do not use test leads which differ from those originally furnished with the Instrument.

4.2.11 Do not float any measuring terminal more than 1000 volts (DC plus AC peak) with respect to the power line or earth ground.

4.3 PRELIMINARY NOTES AND CHECKS

NOTE: Prior to operation of the Instrument, review and perform (where applicable) the following notes and checks. These steps can be used also as a general functional check.

4.3.1 The 461 is supplied with rechargeable nickel cadmium batteries that are factory installed.

CAUTION

Do not operate the instruments with cells in the completely discharged state.

4.3.2 To recharge the battery, follow this procedure:

a. Set the POWER switch to the OFF position and connect the charger to the 461.

b. Connect the charger into a power outlet which conforms to the power requirements of the Instrument as marked on the rear panel, and to the latest electrical code.

c. The battery is being charged at full rate (allow 12 hours for full charge).

4.4 GENERAL FUNCTIONAL CHECK

a. Connect the black test lead to the "−" jack and the red test lead to the "+" jack. Short the test leads together.

b. Depress and set the "kΩ" function and "2" range switches.

c. Separate the test leads. The numerical display will blank in the out-of-range condition.

d. Short the test leads together. The display reading will return to .000 ±1 digit.

e. If difficulty is encountered in the above steps, see Section 6, Table 6-1.

4.5 DC VOLTAGE MEASUREMENTS

a. **Review the Safety Precautions in paragraph 4.2.**

b. Connect input test leads to the "+" and "−" terminals.

c. Depress the "$\frac{\text{⎓}}{\text{V}}$" function switch.

d. Depress the appropriate voltage range switch. If the voltage being measured is unknown, begin with the 1000 volt DC range switch.

e. Turn off the power to the device or circuit under test and

discharge all capacitors.

CAUTION

Do not attempt to measure voltages on the 1000 VDC range which might be greater than 1100 volts DC.

f. Connect test leads to the circuit being measured.

g. Apply power to the circuit being measured. The Instrument will automatically indicate the correct polarity. The value of the voltage being measured will be indicated on the numerical display.

h. **Remove all power from the circuit being measured and discharge all capacitors prior to disconnecting test leads.**

4.6 AC VOLTAGE MEASUREMENT

a. **Review Safety Precautions in Paragraph 4.2.**

b. Connect input test leads to the "+" and "−" terminals.

c. Depress the " $\tilde{V}$ " function switch.

d. Depress the appropriate voltage range switch. If the voltage being measured is unknown, begin with the 600 VAC range switch.

CAUTION

Do not attempt to measure voltages on the 600 VAC range which might be greater than 650 volts.

e. Remove all power from the circuit being measured and discharge all capacitors.

f. Connect test leads to the circuit being measured.

g. Apply power to the circuit being measured. The value of the voltage being measured will be indicated on the numerical display.

h. **Remove all power from the circuit being measured and discharge all capacitors prior to disconnecting test leads.**

4.7 RESISTANCE MEASUREMENTS

4.7.1 General

a. **Review the Preliminary Notes and Checks in Paragraph 4.3.**

b. Connect input test leads to the "+" and "−" terminals.

c. Depress the "kΩ" function switch.

d. Depress the appropriate resistance range switch.

e. If the resistance being measured is connected into a circuit, be certain that all power is removed from the circuit and all capacitors are discharged. Check for current paths other than through resistance being measured. These paths can result in a measured value which is lower than the actual value of the resistance being measured.

f. Connect the test leads to the resistance being measured. Be careful not to contact adjacent points, even if insulated, particularly when making high resistance measurements. Some insulators can have relatively low insulation resistance, which can sufficiently shunt the resistance being measured to result in a measured value lower than the presumed value.

NOTE: If the resistance being measured is polarity or voltage sensitive (for example, semiconductors), careful considerations must be given when making connections and selecting the resistance range.

g. Allow time for the display to stabilize. This procedure is especially important when measuring a high value resistance shunted by a large value of capacitance.

h. Disconnect test leads.

4.7.2 Diode Test

a. The forward voltage drop of a diode can be measured at 1 MA by using the 2 kΩ range. The diode under test must be out of its

circuit. Simply connect the "+" lead to the anode and the "−" lead to the cathode of the diode. For silicon diodes, the Instrument should display .550 or higher. For germanium diodes, the Instrument should display .450 or lower.

NOTE: The above indications are in volts.

b. To measure the reverse resistance of a semiconductor junction, the Instrument should display "overrange".

4.8 DC CURRENT MEASUREMENTS

a. **Review Safety Precautions in Paragraph 4.2.**

b. Depress the "$\frac{\text{⎓}}{\text{mA}}$" function switch.

c. Depress the appropriate current range switch. If the current being measured is unknown, begin with the 2000 switch.

d. **Remove All Power To The Circuit Being Measured and Discharge All Capacitors.**

e. Connect the test leads.

f. Open the circuit in which the current is to be measured and securely connect the test leads in series.

CAUTION

Insure that the 461 is not connected across a voltage source which can exceed ratings of the Instrument.

g. Apply power to the circuit being measured.

h. The value of the current being measured is indicated on the numerical display.

i. **Remove All Power From The Circuit Being Measured and Discharge All Capacitors.**

j. Disconnect the test leads and reconnect the circuit which was originally opened.

4.9 AC CURRENT MEASUREMENTS

a. **Review Safety Precautions in Paragraph 4.2.**

b. Depress the " $\underset{\text{mA}}{\sim}$ " function switch.

c. Depress the appropriate current range switch. If the current being measured is unknown, begin with the 2000 switch.

d. **Remove All Power From The Circuit Being Measured and Discharge All Capacitors.**

e. Open the circuit in which the current is to be measured and securely connect the test leads in series.

CAUTION

Insure that the 461 is not connected across a voltage source which can exceed ratings of the instrument.

f. Connect the test leads.

g. Apply power to the circuit being measured.

h. The value of the current being measured is indicated on the numerical display.

i. **Remove All Power From The Circuit Being Measured and Discharge All Capacitors.**

j. Disconnect the test leads and reconnect the circuit which was originally opened.

SECTION V

THEORY OF OPERATION

5.1 OVERALL SYSTEM

The basic system block diagram for the 461 is shown in Figure 5-1.

5.1.1 Signal Conditioning Section

The parameter being measured is connected to the input terminals. The corresponding Signal Conditioning circuits convert this parameter into a proportional DC voltage. The conversion is accomplished by the Attenuator, Current Shunts, Resistance Converter, AC-to-DC Converter, and associated switching.

5.1.2 Analog-To-Digital Converter Section

The Analog-To-Digital (A/D) Converter section changes the DC output voltage from the Signal Conditioning section to digital information. Using a Large-Scale Integration (LSI) circuit, the unique A/D converter automatically eliminates zero error.

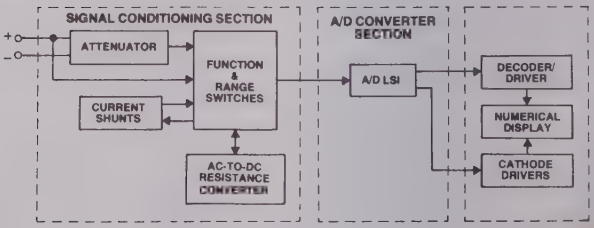

Figure 5-1. Basic System Block Diagram

5.1.3 Display Section

Digital information in BCD form from the A/D Converter section is decoded into 7-segment information by the Decoder/Driver. The decoded information, in conjunction with the Cathode Drivers, is visually presented on the Numerical Display.

5.2 INPUT CIRCUITS

5.2.1 DC Voltage Measurements

The basic DC voltage measurement circuit is shown in Figure 5-2(A). The DC voltage being measured is connected to the "+" and "–" jacks, attenuated according to the range selected and converted into digital information by the A/D Converter.

5.2.2 The A/D Converter circuit provides two basic full range sensitivities: 200mV and 2V. No attenuation is required on the 200mV and 2V ranges. The attenuator is used on the 20V, 200V, and 1000 Volt Ranges.

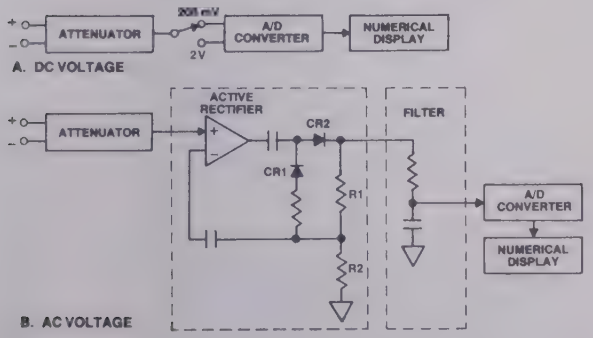

Figure 5-2. Basic Voltage Measurement Circuits

5.2.3 AC Voltage Measurement

The basic AC voltage measurement circuit is shown in Figure 5-2(B). The AC voltage being measured is connected to the "+" and "−" jacks, attenuated according to the range selected and applied to the amplifier. The output of the amplifier is converted into DC voltage by an active rectifier and the resulting DC voltage is measured by the A/D Converter.

5.2.4 The AC-To-DC Converter provides two basic full range sensitivities: 400mV and 2V. The converter is average responding but its calibration (gain) is based on the rms value of a sine wave.

5.2.5 The AC-To-DC Converter consists of a precision half-wave active rectifier and is applied to the non-inverting input of the operational amplifier. Negative feedback causes the voltage at the inverting input to follow the non-inverting input, causing a current Ein/R2, through R2 to circuit common. Since diodes CR1 and CR2 conduct on alternate half cycles, one-half of the average current flows through R1. The rectified voltage developed across R1 is filtered by the RC filter to produce the DC voltage required for the A/D Converter.

5.2.6 DC Current Measurements

The basic DC current measurement circuit is shown in Figure 5-3(A). The current being measured is connected in series with the "+" and "−" jacks, across an internal precision shunt resistance. The value of the shunt resistance depends on the current range selected. The DC voltage developed across the shunt resistor is measured by the A/D Converter.

5.2.7 The full range sensitivity of the A/D Converter is set for 200mV. The internal shunt resistance for each current equals 200mV divided by the full range current. For example, if the full range current is 200μA, the shunt resistance is 1000 ohms.

5.2.8 AC Current Measurements

The basic AC current measurement circuit is essentially the same as the DC current measurement circuit (refer to paragraph 5.2.6), except that the voltage developed across the internal shunt resistance is measured by the AC voltage measurement circuit.

5.2.9 Resistance Measurements

The basic resistance circuit is shown in Figure 5-3(B). The resistance being measured, Rx, is connected to the "+" and "−" jacks and a constant current is applied through it by the Instrument. The resulting voltage is proportional to the value of Rx.

5.2.10 The operational amplifier bootstraps the constant current source. With the non-inverting input connected to the junction of Ra and Rx such that a constant voltage is maintained across Ra for a given range. The voltage developed is proportional to the value of Rx.

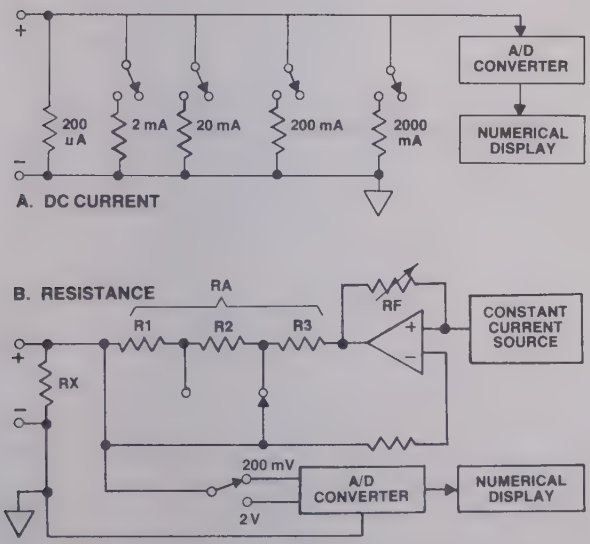

Figure 5-3. Basic DC Current and Resistance Measurement Circuits

NOTES

SECTION VI

OPERATOR SERVICING

WARNING

The following operator servicing instructions are intended to be used by qualified personnel, for limited maintenance of the instrument. Do not perform any servicing other than that contained in these operator instructions. Return the instrument to a Simpson Authorized Service Center, or to the factory for other maintenance not covered in this section.

6.1 GENERAL

The Model 461 is carefully designed and constructed with high quality components. By providing reasonable care and following the instructions in this manual, the user can expect a long, useful service life from his Instrument.

6.2 WARRANTY

The Simpson Electric Company Warranty policy is printed on the inside back cover of this manual. Read carefully before requesting a warranty repair.

NOTE: For assistance of any kind, including help with the instrument under warranty, contact the nearest Authorized Service Center listed on the last pages of this manual or contact the Factory Service Manager. Give full details of the difficulty and include the model and serial number of the unit and date of purchase. Shipping instructions will be promptly sent to you. If an estimate of charges for non-warranty work or other service work is required, a firm quote estimate will be furnished upon receipt of the unit. Service work will not be performed without customer approval.

6.3 SHIPPING

6.3.1 Pack the Instrument carefully and ship it prepaid to the proper destination. Insure the Instrument.

6.4 COVER REMOVAL

The rear cover can be removed for maintenance purposes by the following procedures.

WARNING

Remove all power and connections to the Instrument before removing the case cover. Do not operate the Instrument with the rear cover removed.

a. Depress the POWER switch to the OFF position.

b. Disconnect the charger and the test leads from the Instrument.

c. Turn the two screws on the back cover counterclockwise until the rear cover is removed. (The two screws will remain in the cover.)

d. Reverse this procedure when replacing the cover.

6.5 BATTERY INSTALLATION

6.5.1 Refer to Table 7-1 for recommended batteries.

CAUTION

Standard carbon zinc or alkaline "AA" size cells can be used in an emergency. However, the charger must be removed to prevent charging these cells in the Instrument. These cells do not have provision for pressure relief and can burst when charged. Immediately remove the cells when the emergency is over or when they are discharged and replace with nickel cadmium cells at your earliest convenience.

6.5.2 Replace the Cells As Follows:

a. Remove rear cover (refer to paragraph 6.4). Remove the old batteries with the retainer tubings from the battery holder. Insert two new cells into each retainer. Then install the combination into the holder. Insure that the cells are installed according to the polarity orientation designated on the battery holder label. **Failure to do so can damage the 461.**

b. Check that the battery contacts are clean and making good connection.

c. Replace the rear cover.

d. For battery recharging, refer to paragraph 6.6.

6.6 BATTERY CHARGING

WARNING

To avoid dangers associated with recharging batteries use only Nickel-Cadium type batteries recommended in Table 7-1.

6.6.1 The battery is being charged at full rate when the POWER switch is set to the OFF position and AC power is applied to the charger. Approximately 12 hours are required to fully charge the battery in this mode of operation.

6.7 BATTERY CARE

6.7.1 Avoid discharging the cells completely.

6.7.2 Do not operate the Instrument with discharged cells. Make sure to recharge all newly purchased batteries (refer to 6.6.1 above) for at least 15 minutes before operating the Instrument.

6.7.3 Whenever the charger is not connected and the Instrument is not in use, remember to set the POWER switch to the OFF position.

6.8 FUSE REPLACEMENT

6.8.1 The current fuse is mounted inside on the Battery Board as shown in Figure 6-1. Use the following procedure to replace a fuse.

WARNING

Remove all power and input connections to the Instrument before removing rear cover.

6.8.2 Remove rear cover as described in paragraph 6.4.

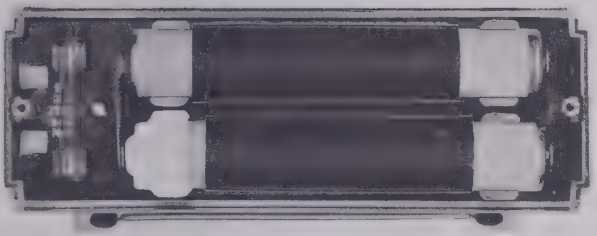

Figure 6-1. Model 461, Fuse Location

CAUTION

Do NOT replace a blown fuse with a fuse which has a larger rating or slower time lag characteristic than those specified.

6.8.3 Carefully lift the defective fuse from the holder and replace with appropriate fuse (refer to Table 7-1).

6.8.4 Replace the rear cover.

6.8.5 If the current ranges are still inoperative, it may be possible the F2 is blown. If this is the case, a large amount of energy has been applied to the current ranges. F2 is inside the unit and must be replaced by your qualified service center.

6.9 PREVENTIVE MAINTENANCE

6.9.1 Daily Care

WARNING

Do not attempt to clean this Instrument with the test leads connected to a power source or when it is connected to the charger.

a. Immediately clean all spilled materials from the Instrument

and wipe dry. If necessary, moisten a cloth with soap and water to clean plastic surfaces.

b. Do not allow the battery to fully discharge. A completely discharged battery may be forced into reverse polarity which will shorten battery life.

c. Whenever possible, avoid exposure or usage in areas which are subject to temperature and humidity extremes, vibration or mechanical shock, dust or corrosive fumes, or strong electrical or electromagnetic interference.

6.9.2 Monthly Care

Verify Instrument calibration by performing operational checks using known value sources. If the need for calibraion is indicated, contact your nearest Authorized Simpson Service Center.

6.9.3 Annual Care

It is recommended that the Instrument be returned annually to a Simpson Authorized Service Center or the factory for a complete overall check and calibration.

6.9.4 Storage

When the Instrument is not in use, store it in a location free from temperature extremes, dust and corrosive fumes, and mechanical vibration or shock.

6.10 TROUBLESHOOTING

6.10.1 If the Instrument does not yield satisfactory results, follow this procedure before attempting maintenance on the Instrument.

a. Review and comply with the Preliminary Notes and Checks, listed in paragraph 4.3.

b. Check that all switches are positioned correctly for the parameter and range of value being measured and that the measurement situation is within the ratings of the Instrument.

c. Be sure that the cells are charged and properly installed (refer to paragraph 6.5).

d. If the 461 has been operated with charger, insure that power source is within the Instrument specifications, and free from excessive fluctuations and transients.

e. Insure that the environment in which the Instrument is being used is within the Instrument specifications.

f. Inspect the device being measured and the measurement test set-up to insure that proper shielding and grounding techniques have been used. Also consider whether the Instrument is significantly affecting the circuit being measured.

6.10.2 If the steps taken in paragraph 6.10.1 do not yield satisfaction, refer to the troubleshooting chart (Table 6-1). Direct all other repair and adjustment needs to a Simpson Authorized Service Center.

Table 6-1. Troubleshooting Chart

Symptom	Probable Causes	Cure
1. LOW intensity on numerical display in battery operation.	Cells not fully charged	Recharge batteries overnight.
2. Batteries do not respond to charge. Read out is dim when charger is used.	Cells defective, not installed properly, making poor contact, or missing.	Remove cover and check that cells are installed correctly and making good contact. Refer to 6.5. If they are, check the voltages of the individual cells. Replace those which check significantly lower than normal (1.25 volts).

Symptom	Probable Causes	Cure
3. Indication fluctuates under all conditions.	Batteries not making contact, or Instrument is without batteries.	Locate the defective contact or install a new set of batteries.
4. Indications fluctuate and/or drift, even though indication is OK at 000 with the input terminals shorted, and at 1000 counts when using a stable and low impedance input.	Fluctuations and/or drift are being generated by the device being measured or the measurement test set up.	Use proper shielding, grounding techniques and connections to minimize "pick-up" of unwanted signals due to ground loops, poor connections, and capacitive and/or inductive coupling.
5. Slow response. Operation OK when using a low impedance input.	Parameter being measured has a high source impedance.	None required.
6. Accuracy not within specifications when checked with a stable, higher accuracy (at least 5 times better) low impedance (voltage measurements) source.	Instrument is out of calibration.	Contact nearest Simpson Authorized Service Center.
7. Accuracy of Instrument is within specifications but measurements appear in error.	a. Instrument affects circuit being measured.	a. Study circuit being measured vs. Instrument specifications. Correct indications accordingly.
	b. Common and/or normal mode specifications is being exceeded.	b. Refer to cure in item 4 above.

Symptom	Probable Causes	Cure
8. Operation normal on all functions and ranges except AC and DC Current.	Current fuse F_1 open.	Replace fuse F_1. Refer to 6.8.
9. Operation normal on all functions and ranges except AC and DC Current (F_1 checks OK)	Current fuse F_2 open.	If F_2 has been blown, a large amount of energy has been applied to the current ranges. This measurement condition must be corrected before replacing F_2.

SECTION VII

ORDERING INFORMATION, SCHEMATIC DIAGRAM, AND AUTHORIZED SERVICE CENTERS

Table 7-1. Items Furnished With Instrument

Quantity	Description	Part No.
1	Test Lead Set: One black and one red insulated lead having probe tips with provisions for screw-on alligator clips (one red and one black supplied).	10-830676
1	Battery Charger, 120 VAC	00745
1	Battery Charger, 230 VAC(optional)	00746
1	Operator's Manual	6-110119
4	Battery, AF size, 1.25V, 0.8 AMP-HRS Nickel-Cadmium	6-110060
	Accessories	**Cat. No.**
	Carrying Case	00747

Table 7-2. Replacement Parts List

Reference Symbol	Description	Part No.
F1	Fuse, Current, 2A, 250V, 3AG, NB	1-112911
F2	Fuse, Current, 4A, 1000V, Type HVW, Bussman	6-110061
	Board, Printed Circuit, Range	5-119946
C101,102 104	Capacitor .1 μF ±20% 100V	5-113612
C103	Capacitor 100 pF ±20% 1kV	5-113217
C105	Capacitor 10 μF 16V	5-117205
C106,107	Capacitor 100 μF 10V	5-117206
C108	Capacitor 47 μF 16V	5-118432
D101,102	Diode, Silicon IN5059	5-113826

D103,104, 105	Diode, Silicon IN914	5-112004
IC101	I.C. .3½ Digit A/D Converter	5-119926
IC102	I.C., Decoder-Driver	5-119927
IC103	I.C., MOS to LED Hex Driver	5-119928
IC104	I.C., Voltage Converter	5-119925
Q101	Transistor, FET 2N4302	6-110059
R101	Resistor, 1.0 kΩ ±.5%, 1/4W	5-119938
R102	Resistor, 111Ω ±.5%, 1/4W	5-119939
R103	Resistor, 10.1 Ω ±.5%, 1/4W	5-119940
R104	Resistor, 0.986 Ω ±1%, .6W	6-110117
R105	Resistor, 0.080 Ω ±1%, .6W	6-110116
R106	Resistor, 10 kΩ ±10%, 1/4W	5-113624
R107,109, 111	Resistor, 100 kΩ ±10%, 1/4W	5-115514
R108,110	Resistor, 470 kΩ ±5%, 1/4W	5-116631
R112	Resistor, 4.7 kΩ ±10%, 1/4W	5-113873
R113,114, 115,116, 117,118, 119	Resistor, 100 Ω ±5%, 1/4W	5-117178
R120	Resistor, 2.49 kΩ ±1%, 1/4W	5-117270
R121	Resistor, 11.0 kΩ ±1%, 1/4W	5-118760
R122	Potentiometer 1kΩ ±20%	6-110472
R123	Resistor, 3.62 kΩ ±1%, 1/4W	6-110062
R124	Potentiometer, 250 Ω ±20%	6-110471
R125	Resistor, 372 Ω ±1%, 1/4W	5-118052
R126	Potentiometer, 100Ω ±20%	6-110450
R127	Resistor, 487 Ω ±1%, 1/4W	5-117466
ZD101	Diode, Ref. Zener, 6.4V ±5% 1MA IN4570	5-119942
ZD102	Diode, Zener, 8.2V ±5% 1W IN4738A	6-110002
	Switch, Push-Button, Range	5-119930
	Board, P.C., Function	10-863641
C301	Capacitor .047 μF 630V	5-119945
C302	Capacitor 2.2 pF 1kV	5-114987
C303,305	Capacitor, Trimmer 4.5-50	6-110125
C304	Capacitor 470 pF 250V	5-118406
C306	Capacitor .033 μF 250V	5-111702

C307	Capacitor 100 pF 1kV	5-113217
C308	Capacitor 10 μF 16V Elctlt	5-117205
C309	Capacitor .47 μF 16V Tantalum	5-118564
C310	Capacitor .22 μF 100V	5-118750
D301,302, 303,304	Diode, Silicon 75 PIV 75 MA IN914	5-112004
IC301	I.C. OP-AMP	5-115928
IC302	I.C. OP-AMP	5-119184
R301	Resistor, 9 MEG Ω $\pm$.1% 2W	5-119932
R302	Resistor, 900 kΩ $\pm$.1%, 1/4W	5-119933
R303	Resistor, 90 kΩ $\pm$.1%, 1W	5-119934
R304	Resistor, 9.0 kΩ $\pm$.1%, 2W	5-119935
R305	Resistor, 1 kΩ $\pm$.1%, 2W	5-119936
R306	Resistor, 470 kΩ $\pm$10%, 2W	5-118421
R307	Resistor, 150 kΩ $\pm$10%, 1/2W	1-113677
R308	Resistor, 330 kΩ $\pm$5%, 1W	5-117936
R309	Resistor, 470 kΩ $\pm$5%, 1/4W	5-116631
R310	Resistor, 2.2 MEG Ω $\pm$10%, 1/4W	5-115441
R311,321	Resistor, 2.0 kΩ $\pm$1%, 1/4W	5-115500
R312,315	Resistor, 4.99 kΩ $\pm$1%, 1/4W	5-115502
R313,314	Resistor, 49.9 kΩ $\pm$1%, 1/4W	5-115525
R316	Resistor, 1 kΩ $\pm$5%, 3W	5-119931
R317	Resistor, 448 Ω $\pm$.25%	5-118411
R318	Resistor, 4.08 kΩ $\pm$.25%, 1/4W	5-118412
R319	Resistor, 7.44 kΩ $\pm$1%, 1/4W	5-119937
R320	Potentiometer 1kΩ $\pm$20%	6-110472
R322	Resistor, 20 Ω $\pm$5%, 1W	6-110123
	Switch, Push-Button, Function	5-119929
	Printed Circuit Board, Readout	5-119948
DS201	Readout, LED, $\pm$1	5-119944
DS202,203 204	Readout, LED, 7 Segment	5-119943
R201,203, 205,207	Resistor, 100 Ω $\pm$5%, 1/4W	5-117178
R202,204, 206	Resistor, 10 kΩ $\pm$10%, 1/4W	5-113624

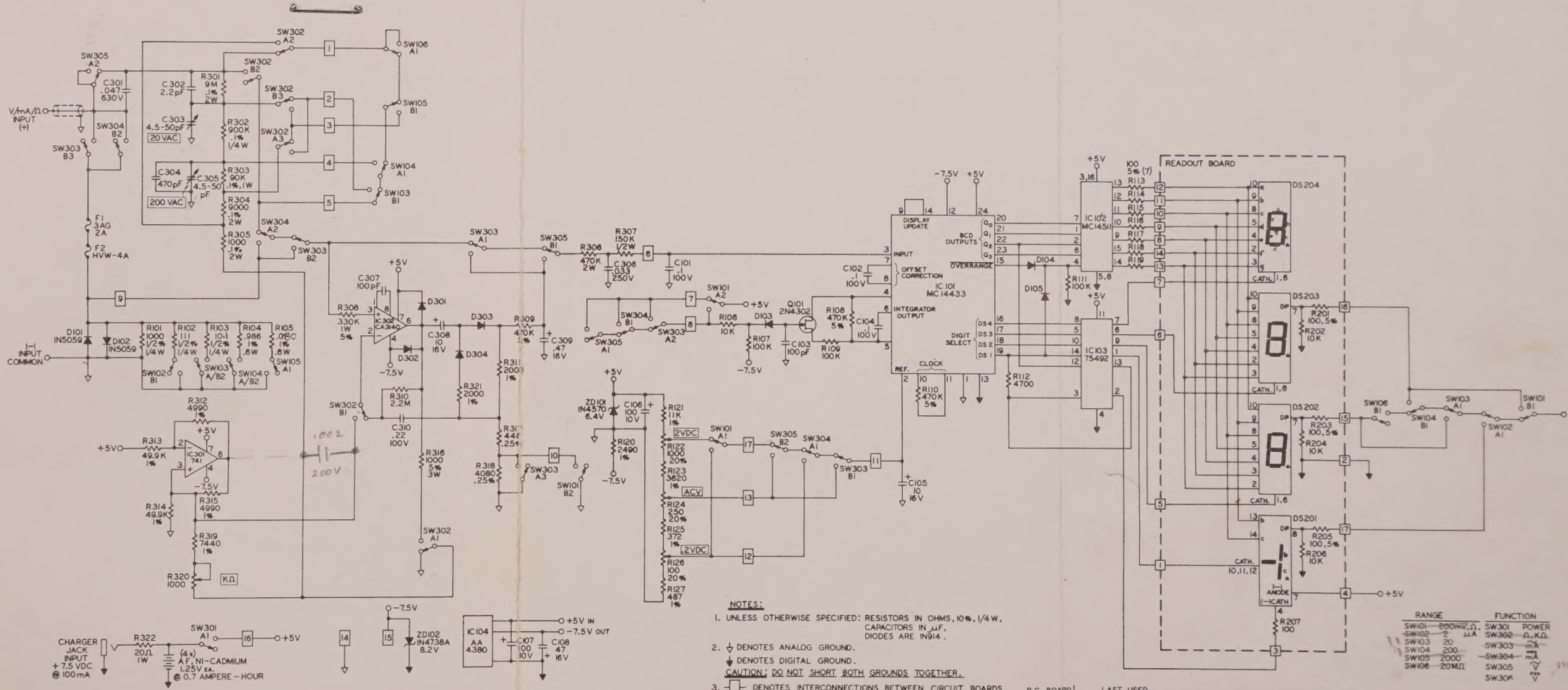
READOUT BOARD
NOTES:
1. UNLESS OTHERWISE SPECIFIED: RESISTORS IN OHMS, 10%, 1/4 W, CAPACITORS IN µF, DIODES ARE IN914.
2. ⏚ DENOTES ANALOG GROUND.
⏚ DENOTES DIGITAL GROUND.
CAUTION: DO NOT SHORT BOTH GROUNDS TOGETHER.
3. DENOTES INTERCONNECTIONS BETWEEN CIRCUIT BOARDS.
R.C. BOARD | LAST USED
RANGE | R127 | C108 | Q101 | ZD102 | D105 | IC103 | SW106 | F2
READOUT | R207 | | | | | DS204 | | |
FUNCTION | R322 | C310 | | | D304 | IC302 | SW306 |
RANGE | FUNCTION
SW101 200mV,Ω, SW301 POWER
SW102 2 µA SW302 Ω, KΩ
SW103 20 SW303 mA
SW104 200 SW304 mA
SW105 2000 SW305 V
SW106 20MΩ SW306 V

Figure 7-1. Model 461, Schematic Diagram

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